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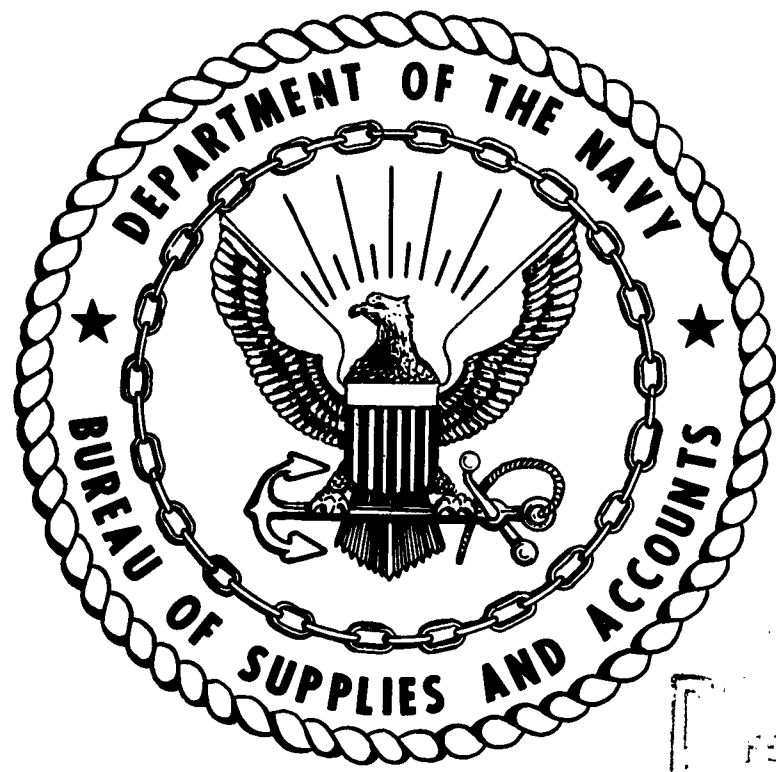
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THEORY AND DEVELOPMENT OF UNIVERSAL LEATHER TESTER AND SOLE LEATHER PERFORMANCE PARAMETERS

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THEORY AND DEVELOPMENT OF UNIVERSAL LEATHER TESTER
AND SOLE LEATHER PERFORMANCE PARAMETERS

by

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ABSTRACT

New developments in sole leather technology have made it essential to develop realistic performance standards and subordinate the use of arbitrary physical and chemical limits. Accordingly, instrumentation was designed which enables abrasive evaluation of soles under dry conditions, in water, and in acid or alkali media. The machine simultaneously tested water resistance and wet abrasion resistance. Results indicated that three performance parameters: dry abrasion, wet abrasion, and dynamic water resistance may be used to determine significant differences between sole leathers.

SUMMARY

PROBLEM

To develop performance standards in order to realistically evaluate sole leather.

CONCLUSIONS

1. Work done on the development of multiperformance parameters for sole leather resulted in the design of a tester that is capable of evaluating the material under a variety of wear conditions.
2. Results showed that wet wear and water resistance of sole leather could be simultaneously evaluated. Wet wear was considerably more severe than dry wear.
3. Preliminary work suggested that a vector embracing dry abrasion, wet abrasion, and dynamic water resistance could be used as a practical means of evaluating the relative serviceability of different sole leathers under normal Navy conditions.
4. Length of the fibers obtained during abrasions may be used as a rapid, rough means of approximating relative durability of materials (i.e. Large fibers - rapid wear; small fibers - slight wear).

RECOMMENDATION

Based on the results of this study, it is recommended that additional tests be conducted on impregnated and nonimpregnated sole leathers in order to develop specific performance values.

Consideration should be given to investigating comparative durabilities of different polymeric materials based on a multiparametric abrasion method.

Some attempt should be made to relate the size and structure of the abraded waste wear particles to durability.

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THEORY AND DEVELOPMENT OF UNIVERSAL LEATHER TESTER AND SOLE LEATHER PERFORMANCE PARAMETERS

INTRODUCTION

It is generally recognized that wear is a complicated phenomenon and the resultant of many influences. Because wear is diffuse and conditions are always changing, no one test seems able to predict material durability (1). This experience accounts for many erratic correlations between abrasion tests and wear trials on most materials (2), including sole leather and has posed a problem (3,4). The following new developments suggested the need for resolution:

1. Performance tests were required to obviate restricting chemical and physical specifications and to encourage the development of new materials (5).

2. Results of extensive coordinated wear trials and abrasion evaluations emphasized the practicability of abrasion tests as a measure of leather durability (6,7). Also, related investigations highlighted the serious limitations of chemical-physical criteria for evaluating impregnated sole leather (8) which is used by the Navy and required on all military oxfords.

3. Fundamental work on the basic factors that affect durability (9,10,11) gave insight into the causes of wear and enabled the development of a simplified means of assessing sole leather.

4. Instrumentation (12) was at hand that lent itself to modification for control of the various kinds of wear mechanisms.

The crux of the early problem lay in the attempt to relate a single test procedure to wear situations obviously affected by several factors. Based on what was learned, if it were practical to isolate the major causes of leather wear, laboratory tests conducted under each distinctive influence could provide the necessary values; and these would be the components of a profile capable of being correlated with all kinds of service situations. At the same time, this data would be available for specification purposes. The environments that accelerate the degradation of leather soles are well known. Simultaneous with physical influences, they include water, hot-wet conditions (hydrothermal instability), and excessive corrosive materials such as acids, alkalis, electrolytes, and specific organic compounds. By relating a vector comprised of abrasion measurements obtained under these separate dry and deleterious conditions, it

might be possible to predict the durability of new materials and specify sole leather more realistically. In a major respect this vector or profile could be considered more realistic than a wear test because it could anticipate conditions impossible to obtain at any one place at any one time, even in ambitious field trials. As in the case of limited laboratory tests where one type of abrasion data is obtained, the results of a singular wear test cannot be used to generalize the value of materials. Nor does a wear trial necessarily reflect on the validity of a laboratory procedure. Mitton reported that similar soles worn in dissimilar environments, as expected, did not show high correlation (6).

It was, therefore, believed that an instrument should disclose a variety of information, since several parameters would provide a profile of behavior and enable prediction under all conditions. This approach was investigated and a multi-parameter instrument developed. This work including evaluation of some commercial sole leathers on the Universal Leather Tester are discussed in this report.

PROCEDURE

Mann and Merhib (12) had developed a dynamic tapping tester intended for evaluating water resistances of glove and shoe upper leathers (see Figure 1). The instrument had four arms that could hold four specimens against four rotating cylindrical anvils with varying force. The anvils rotated at approximately 40 rpm partially submerged in water. The structure, shape, and concept of the machine resembled the NBS rubber abrader of Holt (13), used to evaluate rubber soles and heels. The water resistance tester was inexpensive, easy to maintain, and recognized as a practical instrument. Examination showed that the tester could be fashioned into a wear tester for wet, dry, or other controlled testing while also enlarging its water evaluation functions. Work was, therefore, concentrated on the Mann-Merhib machine for sole leather testing and included:

1. Design and engineering of improvements for wear testing.
2. Evaluation of modifications.
3. Development of test procedures.

As conceived by Mann and Merhib the instrument evaluated water resistance of leather by applying regular intermittent impacts or taps against test specimens which fell on a rotating wet anvil. Resistance to water penetration was measured by the number of impacts required to activate an electronic switch of three-megohm sensitivity. Penetration was signaled by the ringing of a bell. But the instrument was restricted to glove and upper leather and not suitable for sole leather.

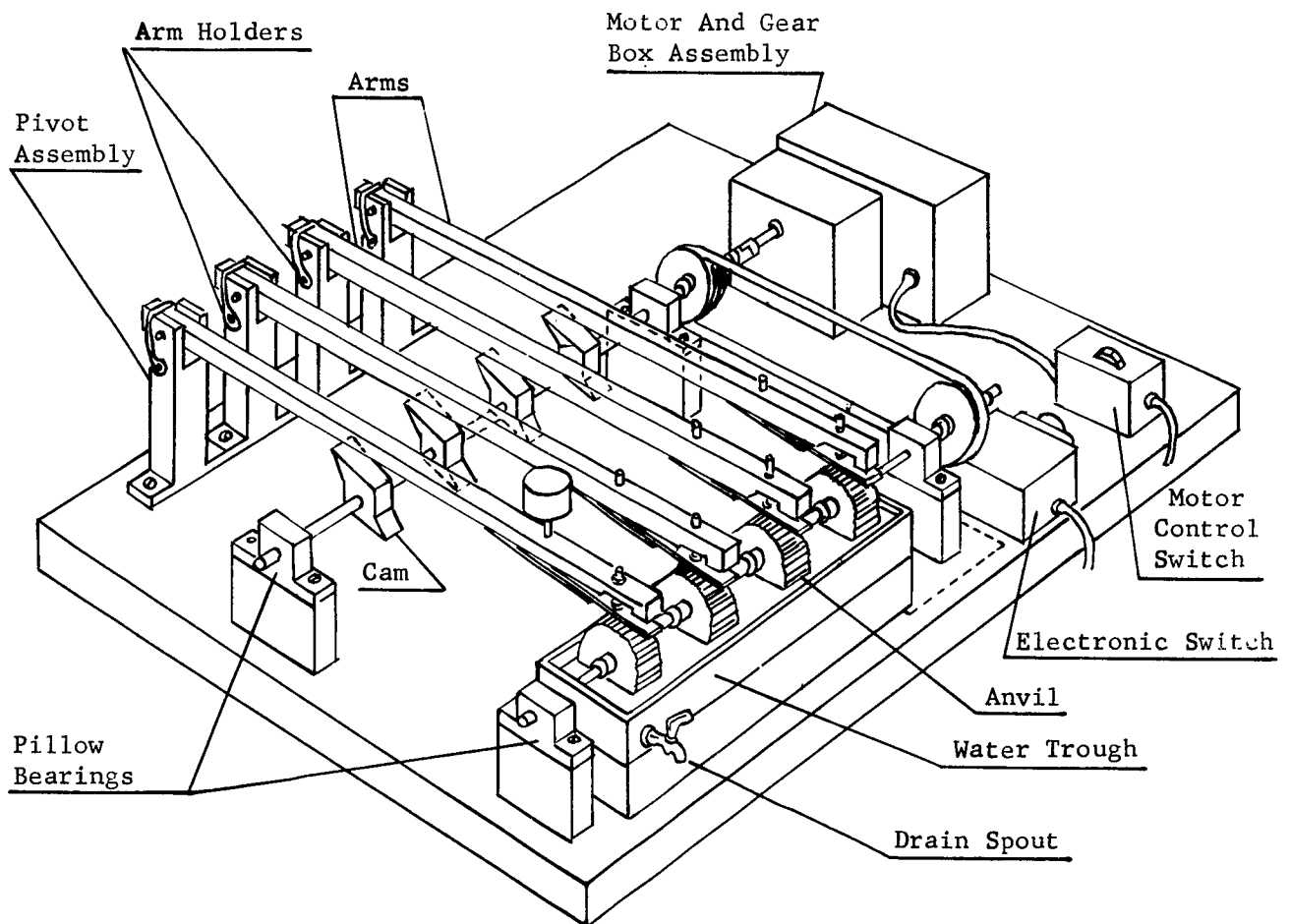


Fig. 1 - Dynamic tapping tester for measuring water penetration.

The machine however was readily modified to reproduce four main types of wear; abrasive wear, adhesive wear, corrosive wear, and wear by surface fatigue as postulated by Rabinowicz (9). (See figures 2,3,4,5). It was also made to measure water resistance of sole leather. These modifications enabled the evaluation of all leathers and soft materials. The changes required were:

1. Nylon anvils for holding sleeves of abrasion paper or abrasion cloth.
2. Friction grooves to secure square-inch sole leather specimens for wet or dry abrasions.
3. Sliding spring flexing mechanism to flex 4" X 1" rectangle of sole leather.
4. Adjustable cams to regulate height of falls or impact against leather when required.
5. Adjustable weights for regulating force against specimens from 1/2 pound to 3-1/2 pounds.
6. An electronic-servo circuit to detect specimen failures and stop instrument.
7. A mechanical counter.
8. Screw lock to hold glove and upper leather specimen.

WEAR TESTING SYSTEM

During abrasion testing, four square-inch sole specimens are inserted in grooves and rubbed by a dry abradant or by an abradant rotating through a water bath. The wet system may also use oils or electrolytes. Since water or polar fluids are generally used, the operation is controlled by the electronic circuit that cuts off the tester and identifies the failed specimen when penetration occurs. The wet test provides dual data simultaneously (water resistance and wear resistance measurements). A 3-1/2-pound weight presses against each specimen.

WET FLEX TESTING

For wet flex testing, a 4" X 1" stiff sole leather is inserted in the sliding spring flexer. The spring arcs the sample. The weight is placed over the arched sample. In each cycle or stroke, the fall of the arm flattens out the specimen against the hammer and causes the specimen to fall against either the metal anvil or the nylon abrading



Fig. 2. Universal Leather Tester with abrasant. Photo No. RT3-2.

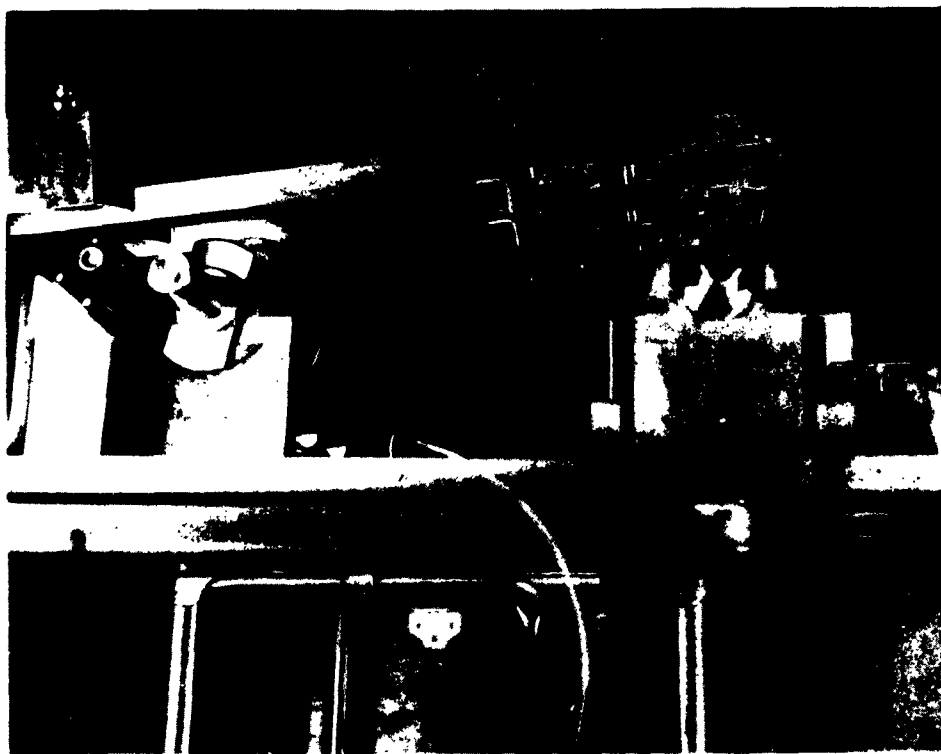


Fig. 3. Underside of Universal Leather Tester showing square-inch slots for holding sole samples. Photo No. RT3-1.

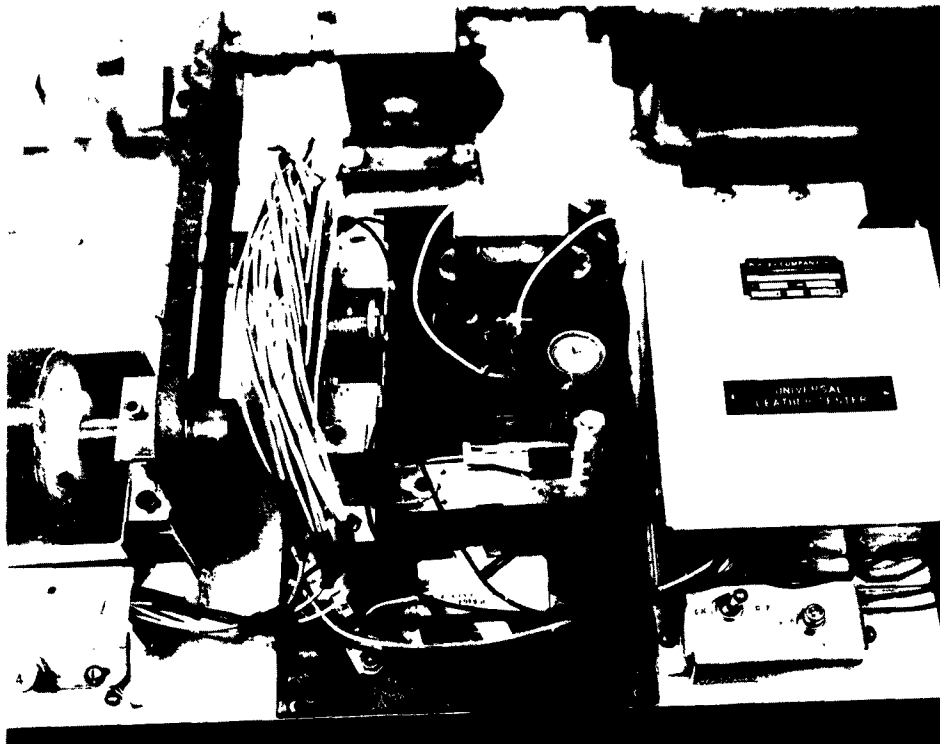


Fig. 4. Servo-control device for detecting specimen failures.
Photo No. RT3-4

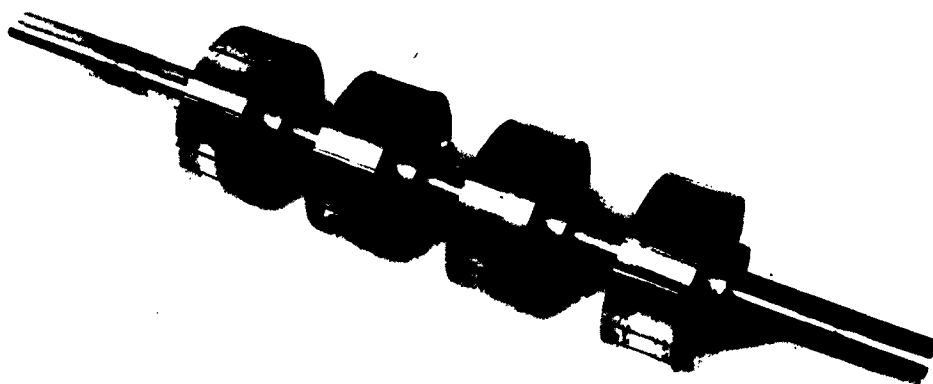


Fig. 5. Monel metal fluted anvil for evaluating water resistance of glove and upper leathers. Photo No. RT3-3.

anvils. The specimens rub against the anvils under 3-1/2-pound pressure until the adjustable cam lifts the arm and a spring re-arcs the sample. Water prevents particles from adhering to the abradant during wet sample runs. The flexing and abrading action is repeated while the electronic circuit searches for a specimen where penetration occurs. Penetration stops the machine and a signal light indicates the particular sample failure.

WATER RESISTANCE EVALUATION OF SOFT LEATHERS

For evaluation of glove or upper leather, the specimens are mounted at the end of the arm with the flesh or unexposed sides in contact with the hammer. In each cycle or stroke, the fall of the hammer causes the specimen to strike a wet metal anvil rotating in water. The specimen then rubs against the rotating anvil under pressure until the cam lifts the arm. This tapping and rubbing action is repeated with each cycle while as above, the electronic circuit searches for a failure. When water penetrates the leather, the resistance is reduced, and the cut-off switch energized. The motor stops as a signal is flashed indicating the particular sample failure. The reading on the counter is noted and the test is continued.

SUMMARY OF IMPROVEMENTS

The new instrument permitted:

1. Simultaneous evaluation of wear and water resistance.
2. Evaluation of all classes of leathers and soft materials for wear and water resistance.
3. Searching and signalling of particular failures and stopping of the machine.
4. The use of small, economical specimen sizes.
5. Rapid setting up of samples and change overs.
6. Compact machine design.
7. Incorporation of several dynamic tests in one device.
8. Automatic cleaning of abrasive during wet testing.

Finally, these improvements made it possible to emphasize and combine the four major kinds of wear:

1. Adhesive wear by controlling of anvil surface and pressures on specimens.

2. Abrasive wear by changing abrasive surfaces and pressures on specimens.

3. Corrosive wear by abrading samples in media such as water, buffered alkaline, acid solutions, urea or specific deteriorating substances.

4. Surface fatigue by flexing mechanism.

TEST RUNS, DATA, AND FINDINGS

GLOVE AND UPPER LEATHERS

Untreated and treated cattlehide glove leathers and stiffer upper shoe leather were inserted under the tap hammer and tested for water resistance. Upper leathers were struck with a 2-pound force, glove leathers with a 1/2-pound force. The purpose of these trials was to test the servo-device and establish the instrument's capacity to detect differences between treated and untreated leathers. The instrument was started and run at 3-megohm sensitivity. These orientation runs showed that leakage through untreated leathers could be detected by as few as 5 taps. Low performing silicone and Bavon-treated (alkenyl succinic acid) leather exceeded 50 taps. The servo-device picked out failures and permitted continuous operation. It operated as designed and was deemed suitable for future controlled evaluations.

TEST OF WATER RESISTANCE AND FLEX MECHANISM FOR SOLE LEATHER

The traditional water resistance standard for impregnated sole leather requires a minimum 12 percent water absorption after 1/2 hour and not more than 35 percent after 24 hours. This test has been criticized because superficial surface treatments will enable leather to meet these requirements, yet wet through rapidly on wearing. It was also observed that the fibers expand causing the tacky polybutenes to exude from specimens during the static soak and still pass requirements. Consequently, dynamic tests are considered more valid and used whenever available.

The dynamic flexing procedure was accomplished on 4" X 1" heavy leather samples that were alternately flexed in the form of an arch and then flattened against the wet rotating monel-metal anvil, virtually without abrasion. The same action was done on a wet abrasive wheel. When water penetrated to the flesh side, the micro-current signalled the machine to stop and the servo-selector pinpointed the failing specimen. Specimens withstood 800 flexes on the smooth surface and resisted up to 490 flexes on the wearing, wet abrasive surface. Abrasion obviously is a major factor in accelerating water penetration.

On occasion, edge wetting carried water to the flesh surface and prematurely activated the signal during the two kinds of flexing. Subsequent experimentation showed that this difficulty could be obviated by coating the edges with a viscous butyl-impregnant, or a petroleum grease as suggested by Baumann (14). In addition, the rotating anvils could not be over immersed, or water would be splashed onto the samples. Simultaneous wet flex-abrasion simulated an accelerated sole wear and wetting but as in other dynamic hydro-flex tests this exploratory work suggested it would be difficult to obtain precise, reproducible water resistance values.

WET ABRASION TESTING

Wet abrasion tests are not unique. They are done after initial wetting of samples (6) or by running abrasants through water. The Navy instrument, currently identified as the Universal Leather Tester contains four nylon wheels, 3-1/4" X 1-1/8" which receive abrasant paper and cloth. These abrading ribbons cover the wheels and whirl through water or any liquid medium. The revolving wheels press against the grain surface of square-inch sole leather specimens fitted into the sample holders, with a constant force of 3-1/2 pounds, approximately 1600 grams. A variety of water resistant silicon carbide abrasive cloths was tried including 60x, 80x, 100x and 120x. The relatively coarse 60x grit of Minnesota Mining and Mineral Company was selected as the standard after several trials because it induced rapid wear and was not easily clogged. Even though the agitated water helped to keep the abrasant clean, the cloth was changed after every three runs to assure a constant grit of uniform coarseness.

DRY ABRASION TESTING

The dry abrasion method is essentially the same as the wet method but the sample remains dry and wears against coarse #30(2-1/2x) Garnet M paper of the Carborundum Company. This abrasant has been standard on the NBS rubber abrader and wears leather more rapidly than finer silicon carbide grits. Although the surface clogs, clogging is cleared by a nylon brush or a blower. Heavy clogging is precluded by replacing the paper after every three runs.

Table I shows the major abrasion features of the Universal Leather Tester.

TABLE I - ABRASIVE FEATURES OF UNIVERSAL LEATHER TESTER

Abrasive	Wet testing - 60x grit silicone carbide cloth (Tri Mite cloth roll) Minnesota Mining & Mineral Co. Dry testing - 30(2- $\frac{1}{2}$ x) Garnet M paper, Carborundum Co.
Shape and size of sample	One square inch, four specimens may be run simultaneously
Pressure on sample	3 $\frac{1}{2}$ pounds per square inch on grain surface
Load control	Dead weight
Load steady or intermittent	Steady
Motion of abrasive relative to sample	7.33 inches per second
Wet abrasion; cleaning of abrasive	Water bath and replacement after 3 runs
Dry abrasion; cleaning of abrasive	By nylon brush, air jet, and replacement after 3 runs
Wet abrasion; conditions of test	Samples wetted by anvils rotating in water or other media held in trough
Dry abrasion; conditions of test	Approximately 20°C relative humidity, not controlled
Abrasion resistance measured by mils/1000 cycles	Thickness losses
Fraction of thickness abraded	25% to 100%
Estimated mils abraded per minute - dry	untreated 3.5 mils/min. treated 2.5 mils/min.
- wet	untreated 9.0 mils/min. treated 6.0 mils/min.
Estimated water resistance cycles/mil to achieve water penetration	untreated 2 cycles/mil. treated 7.5 cycles/mil.

NON-FLEXING WATER RESISTANCE TESTING OF SOLE LEATHER

Normal experience and National Bureau of Standards wear tests with recently developed impregnated leathers showed subjects' feet tend to remain dry after prolonged walking on wet surfaces (15). Sufficient butyl-type impregnant, Vistanexes, and higher molecular weight butyl polymers are apparently retained in the sole matrix, and retard water penetration during extended periods of wear. On the other hand, conventional soles absorb water and wet subjects' feet. This contrasting experience between impregnated versus nonimpregnated soles suggested a simpler realistic laboratory test for establishing the validity and relative effectiveness of treatments and leathers. The sample was run at a pressure of 3-1/2 psi under wet abrasive conditions as outlined below and the end point was signalled by the electronic detector. The number of cycles required to cut-off the instrument divided by the initial thickness of sample represented the relative water resistance of specimens. This measurement indicated probable water resistance during wear in contrast to the nonabrading flex systems of the NBS and European devices (16,17,18). In addition, two kinds of information were obtained: (a) Resistance to wet abrasion; (b) Resistance to water penetration under wear conditions.

ORIENTATION STUDY

A variety of impregnated and nonimpregnated leathers were subjected to wet and dry abrasion in order to observe the operation of the instrument. As suggested above, wet abrasion and water resistance determinations would be mutually dependent and provide dual data. The end point of specimens as measured by the cycles required for water penetration was converted to a thickness loss per thousand cycles. The cycles required for water penetration were divided by the initial thicknesses of the specimen to yield the water resistance factor. Table II shows simultaneous wear and water resistance values developed during the orientation study.

WORN LEATHER

Insight into the nature of abrasive wear and treatments was obtained by scrutinizing the fiber shavings after wet and dry abrasions.

Microscopic examination after dry abrasion of untreated or standard sole leather showed the coarse 30(2-1/2x) garnet grit ripped and pulled the fibers from the leather. The waste was long, discrete, and frequently visible to the naked eye. The same grit yielded a finer residue when used on impregnated leather. The powder was darker and quite cohesive. The impregnant seemed to hold the waste together. The fiber color remained uniformly dark during abrasion, suggesting the following:

TABLE II - WATER RESISTANCE, WET ABRASION, AND DRY ABRASION
INDICES OF SOLE LEATHER

Specimen	Initial Thickness=Ti (Mils)	Final Thickness=Tf (Mils)	Thickness Loss=Ti-Tf (Mils)	Cycles Abraded To Water Penetration=cy	Wet Wear per Thousand Cycles (Mils)	Water Resistance Index= $\frac{cy}{Ti}$	Cycles Abraded (Dry)	Dry Wear per Thousand Cycles (Mils)
Wet Abrasion - Impregnated								
A	260	33	227	1352	168	5.20		
B	257	46	211	1461	144	5.68		
C	255	46	209	1478	141	5.79		
D	252	32	220	1056	208	4.19		
E	219	55	164	897	194	3.86		
F	218	82	136	716	190	3.14		
G	221	61	160	734	218	3.32		
H	214	62	152	700	217	3.27		
Wet Abrasion - Nonimpregnated								
I	177	70	107	243	441	1.37		
J	176	81	95	258	369	1.46		
K	176	70	106	198	549	0.91		
L	184	87	97	205	473	1.11		
M	236	90	146	710	206	3.00		
N	230	60	170	880	193	3.82		
O	239	103	136	704	193	2.94		
P	233	67	166	720	231	3.09		
Dry Abrasion - Impregnated								
R	178	135	43				500	86
S	162	123	39				500	78
Y	200	170	30				750	40
Z	167	146	21				1000	21
Z ₁	144	123	21				1000	21
Z ₃	215	189	26				750	35
Z ₄	210	184	26				750	35
Z ₅	217	188	29				750	39
Dry Abrasion - Nonimpregnated								
Q	173	80	93				500	186
T	185	135	52				750	69
U	228	140	88				750	117
V	220	140	80				750	106
W	244	168	76				750	101
X	244	135	109				750	145
Z ₂	136	112	24				750	32
Z ₆	220	192	28				750	37

an initial deep penetration, probable melting of resin, a continuous flow of impregnant from wearing surface to the sub-surface, and a retransfer of impregnant from the abrasive to the unworn or deeper fibers. Wet wear, done with the finer 60x silicone carbide grit did not highlight size difference between treated and untreated leathers. Some untreated fibers looked lighter; and cool wet wear yielded waste that did not clog the abradant. These waste products disclosed that test conditions (abrasive surface, water, leather treatment) alter the wear process considerably. Specimens which produced fine waste particles seemed to resist wear better than leather that yielded coarse particles.

DISCUSSION OF FINDINGS

The results of the orientation study (Table II) showed that it was possible to obtain the dual values of wet wear and water resistance of sole leather by using water penetration end point. Dry wear abrasion was controlled to an exact number of rotations. Although 500 dry turns generally wore away more than 25% of the corium, a minimum of 1000 cycles seems to provide more reliable information about overall dry-wear durability.

Wet wear was more severe than dry wear. But, in testing untreated soles for wet abrasion resistance, the machine frequently cut off too soon and did not allow for a valid measurement of wear resistance. This premature water penetration sometimes occurred after 8 cycles, hardly enough turns to wear down the grain; consequently a minimum run of 500 wet cycles was required to test the durability of the denser corium fibers. This was accomplished by disengaging the electronic cut-off. The preliminary work suggested that these procedures would operate satisfactorily for treated and untreated samples.

Although the machine is sufficiently versatile to combine the several kinds of wear suggested by Rabinowicz (9), the dead-weight method appears to be a more reliable means for measuring wear. The work also suggested that that various kinds of wet wear could be simulated: wear at buffered acid or alkalai pHs, wear in oil and grease media, wear in deteriorating chemical fluids. Impregnated leathers were revealed as superior in wet wear, water resistance, and dry wear. The results also showed that wear is diverse and gave credence to the theory that these three measurements could provide the information needed to predict overall the relative serviceability of different sole leathers. It was also learned that impregnation and wear conditions affected the particle size of the leather waste. Under comparable conditions more durable leather often produced finer waste fibers. Fiber-particle size may be a good means of estimating relative durabilities after short test runs.

These results indicate that the machine will be useful for predicting the serviceability of sole leathers. Further work should be conducted using a larger sampling of commercial treated and untreated sole leather.

APPENDIX

REFERENCES

- (1) Subcommittee on Wear of Metals, "Metals Handbook," American Society of Metals, 1948, p. 218.
- (2) Howell, H. G., Mieszkis, K. W., Tabor, D., Friction in Textiles. Interscience Publishers, Inc., 1959, p. 235.
- (3) Committee Report, Journal of the American Leather Chemists Association, 40, 1945, p. 339.
- (4) Hobbs, R. B. & Kronstadt, R. A.; Journal of American Leather Chemists Association, 40, 1945, p. 12.
- (5) Bailey, M.; Leather & Shoes, 140, No. 2, 1960, p. 16.
- (6) Mitton, R. G., Journal of Society of Leather Trades Chemists, 45, 1961, p. 130, p. 154.
- (7) Mitton, R. G., Millar, M., and Morgan, F. R.; Journal of American Leather Chemists Association, 56, 1961, p. 486.
- (8) Booth, W. E.; Journal of Society of Leather Trades Chemists, 43, 1959, p. 347.
- (9) Rabinowicz, E.; Scientific American, 206, 1962, p. 127.
- (10) Rabinowicz, E.; Journal of Applied Physics, 32, No. 8, 1961, p. 1440.
- (11) Wear Theory, Massachusetts Institute of Technology, Mechanical Engineering Dept., 1959 approx.
- (12) U. S. Patent 2,942,463; Tap Tester; Mann, E. W. and Merhib, C. P. to U. S. of America, 1960.
- (13) Federal Test Method Standard No. 601, Rubber; Sampling & Testing; Method 14111.
- (14) Conversation with E. Baumann, Vice-President Bally Shoe Factories, Schoenwerd, Switzerland, during visit to U. S. Naval Supply Research and Development Facility, September 19, 1961.
- (15) National Bureau of Standards Report 4413, USN Project No. NT001-018, Progress Report 4, 1955.

APPENDIX

REFERENCES (Cont'd)

- (16) Carter, T. J., Journal of the American Leather Chemists Association, 55, 1960, p. 19.
- (17) Mitton, R. G., Journal of Society of Leather Trades Chemists, 44, 1960, p. 495.
- (18) SATRA Dynamic Water Penetration Machine, Journal of Society of Leather Trades Chemists, 42, 1958, p. 393.

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Attention Technical Reports Section

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Attention Leather Consultant

<p>Naval Supply Research and Development Facility, Bayonne, N. J.</p> <p>THEORY AND DEVELOPMENT OF UNIVERSAL LEATHER TESTER AND SOLE LEATHER PERFORMANCE PARAMETERS, by Milton Bailey and Gerald Schnabel, May 1962.</p> <p>ix p. 13 p. illus. fig. ref.</p> <p>New developments in sole leather technology have made it essential to develop realistic performance standards and subordinate the use of arbitrary physical and chemical limits. Accordingly, instrumentation was designed which enables evaluation of soles under dry conditions, in water and in acid or alkali media. The machine simultaneously tested water resistance. Results indicated that three performance parameters: dry abrasion, and dynamic water resistance may be used to determine significant differences between sole leathers.</p>	<p>1. Leather— Testing equipment</p> <p>I. Bailey, M.</p> <p>II. Schnabel, G.</p> <p>III. Title</p> <p>IV. Sub-Task NT F015-14-301 (2)</p> <p>V. System No. 1202-3902-2</p>	<p>1. Leather— Testing equipment</p> <p>I. Bailey, M.</p> <p>II. Schnabel, G.</p> <p>III. Title</p> <p>IV. Sub-Task NT F015-14-301 (2)</p> <p>V. System No. 1202-3902-2</p>
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